Berryessa Creek Element
Coyote and Berryessa Creeks
Flood Control Project
Santa Clara County, California

Appendix A: Environmental

Part II

Water Temperature Monitoring Report

DRAFT

BERRYESSA CREEK
WATER TEMPERATURE MONITORING

NOVEMBER 2001 – NOVEMBER 2002

March 2003

Coyote Watershed Program
Santa Clara Valley Water District

and

US Army Corps of Engineers
Sacramento District

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

1.1. Project Background

A general re-evaluation study of the December 1993 General Design Memorandum (GDM) for flood protection on Coyote and Berryessa Creeks is being jointly conducted by the Santa Clara Valley Water District (SCVWD) and the U.S. Army Corps of Engineers (Corps). The purposes of this study are to reduce flood damage to populated areas, provide environmental improvements, reduce maintenance requirements, improve fish passage, and increase recreational opportunities, as feasible. A General Re-evaluation Report (GRR) is to be prepared to address the goals and objectives mentioned in the General Re-evaluation Study, and is to include an Environmental Impact Statement (EIS). The GRR/EIS will comply with all applicable laws and regulations and be fully coordinated with other federal, state, and local agencies.

In order to fulfill the requirements of the EIS, a detailed description of existing environmental conditions is necessary. However, existing data were unavailable for many environmental characteristics of Berryessa Creek. For this reason, a number of aquatic, riparian, and wildlife assessments have been conducted to document the baseline conditions. These baseline conditions will provide a standard for comparison of future conditions with project implementation, which will be expected to meet or improve existing conditions. In particular, this report provides baseline temperature characteristics for Berryessa Creek over a one-year period from November 2001 through November 2002.

1.2. Project Location

The Berryessa Creek drainage basin covers 22 square miles in northeastern Santa Clara County, California. Flowing westerly from its headwaters in the Diablo Range, it begins approximately 2000 feet above mean sea level. The creek flows west through the cities of San Jose and Milpitas, and then turns northward and drains into Lower Penitencia Creek, which is a tributary to Coyote Creek that flows into the San Francisco Bay. The basin consists of flat valley and foothill areas, which have been urbanized rapidly. The project area for the study encompasses a 4.5-mile (7.2 km) length of Berryessa Creek, beginning approximately 600 feet (182 m) upstream of Old Piedmont Road and ending at Calaveras Boulevard (Hwy 237).

1.3. Project Objectives

The objective of water temperature monitoring is to provide a baseline of water quality conditions within Berryessa Creek. Aquatic species are restricted to specific temperature ranges. Alterations to Berryessa Creek for the purpose of flood control have the potential to disturb thermal regimes, resulting in loss of stream productivity and fish use. Documentation of water temperature baseline conditions will provide the information needed to determine the existing condition of Berryessa Creek, as well as protect it from potential adverse effects associated with future proposed actions as a result of the general re-evaluation study.

2.0 METHODS

Berryessa Creek was divided into 3 stream reaches based on physical and biological habitat characteristics and also on the proposed project location. The first reach was located at the upstream end of the project area, the second reach included the remaining project area, and the third reach was downstream of the project area. Temperature monitoring was conducted within each of these 3 reaches.

Reach 1. This reach includes the upper 600 feet of the project area, starting from Old Piedmont Road and extending upstream. This portion of the creek runs through the foothills of the Diablo Range and is the least modified reach. This reach generally has intermittent flow, although water may be present in the larger pools during the low-flow season.

Reach 2. This is the middle reach, which encompasses the remainder of the project area. It begins at Old Piedmont Road and continues downstream to the Calaveras Boulevard crossing. This reach includes both the greenbelt area comprised of natural stream habitats and a long length of highly modified channel with concrete or high dirt banks and significant deposits of sand and gravel in the channel bed. This reach does not have perennial flow.

Reach 3. This reach includes the remaining length of the creek from Calaveras Boulevard to its confluence with Lower Penitencia Creek and Coyote Creek. This reach is entirely downstream of the project area. This reach is comprised of highly modified channel, although perennial flow is present throughout most of the reach due to irrigation runoff and other discharges throughout the low-flow season. The lower end of this reach is tidally influenced.

A total of 6 gauges were placed and gauge locations are described in Table 1. Five gauges were within the project area and the sixth gauge was downstream of the project area. Multiple gauges were used to assure the best potential for obtaining year-round water temperature data and to minimize loss of data due to vandalism or other unforeseen circumstances.

Initial gauge deployment occurred on November 15, 2001. Optic Stow-Away Continuous Recording Temperature Gauges were used for this study. Gauges were programmed to record every 30 minutes. Temperature gauge recording memory allowed data to be collected continuously for 5-month long intervals. Within the sampling period of one year, data were downloaded from the gauges a total of 3 times, using BoxCar® Pro 4 software. The first recording period extends from November 15, 2001 to March 22, 2002. The second period ended on August 21, 2002. The final period ended with final gauge collection on November 19, 2002. Temperature data were then imported into Microsoft Excel format for graphing and analysis.

The gauges were placed within the deepest point of the creek, pools or thalweg, at the time of deployment in order to assure submergence of gauges during even low flow periods. Gauges were placed within PVC casings, which were drilled with several holes to allow water flow-through, and locked to prevent theft. The PVC casings were then secured to rebar posts and locked to a nearby tree or other permanent feature using chains.

Table 1. Temperature monitoring gauge locations in Berryessa Creek.

Gauge	Description/ Latitude and Longitude	Location
BRY1	Upstream End of Project Area N37°27.309’, W121°51.206’	Southeast of Arlen Court, approximately 400 feet upstream of Old Piedmont Road
BRY2	Upstream End of Project Area N37°25.267’, W121°51.277’	Southeast of Arlen Court, approximately 200 feet upstream of Old Piedmont Road
BRY3	Middle Project Area N37°24.547’, W121°53.916’	Approximately 200 feet downstream of the footbridge at Berryessa Creek Park
BRY4	Middle Project Area N37°24.506’, W121°52.124’	Upstream of the concrete channel located just upstream of Morrill Road
BRY5	Downstream End of Project Area N37°25.969’, W121°53.547’	Between Los Coches Street and Calaveras Boulevard
BRY6	Downstream of Project Area N37°26.129’, W121°53.604’	Beneath Hillview Drive bridge

3.0 RESULTS AND DISCUSSION

Low flow monitoring was conducted concurrent with temperature monitoring. Intermittent and low flow conditions resulted in collection of water temperature data for only portions of the year at several sites. Upstream of Old Piedmont Road, the creek is intermittent, with flows present from November to mid-June. Throughout the greenbelt area, flows were intermittent and typically occurred only after a rainfall event. At the downstream portion of the monitored creek, near Calaveras Boulevard, the creek flows year-round.

Data were most reliably available from gauges BRY 1, 2, 5 and 6. However, the most reliable data from each reach of the creek were taken from a single gauge. BRY 1 is most representative of Reach 1, BRY 5 provided the most data for Reach 2, and BRY 6 provided the most reliable data for Reach 3.

Water temperatures ranged from a minimum of 38.3°F to a maximum of 84.7°F throughout the entire creek for the year. Temperatures in the upper reach were several degrees cooler than in the lower reaches on average, while the lower reaches had little measurable difference between them. In fact, BRY 5 and 6 temperatures were quite similar, likely due to their close proximity at the lower reaches of the creek.

Average summer temperatures, measured from June 21 to September 19, ranged from 59.8°F to 84.7°F. Winter temperatures, measured from December 21 to March 20, ranged from 38.3°F to 71.3°F. A summary of temperatures at each reach has been provided in Table 2. Average, maximum, and minimum temperatures for seasonal periods is provided in Tables 3 and 4. Monthly average, minimum, and maximum temperatures are represented in Figures 1 and 2.

Table 2. Water temperature average, maximum, and minimum °F (°C) by reach.

Reach	Gauge	Average	Maximum	Minimum
Upper	BRY 1	54.5 (12.5)	78.2 (25.7)	38.3 (3.5)
Middle	BRY 5	62.6 (17.0)	84.7 (29.3)	42.8 (6.0)
Lower	BRY 6	62.6 (17.0)	84.0 (28.9)	42.4 (5.8)

Table 3. Summer1 average, maximum, and minimum temperature °F (°C) by reach.

Reach	Gauge	Average	Maximum	Minimum
Upper	BRY 1	n/a	n/a	n/a
Middle	BRY 5	69.7 (20.94)	84.7 (29.26)	59.8 (15.46)
Lower	BRY 6	69.9 (21.09)	80.5 (26.92)	60.7 (15.97)

[1]Period between June 21 and September 19, 2002.

Table 4. Winter (steelhead ESU spawning period1) average, maximum, and minimum temperature °F (°C) by reach.

Reach	Gauge	Average	Maximum	Minimum
Upper	BRY 1	48.3 (9.02)	57.5 (14.17)	38.3 (3.48)
Middle	BRY 5	55.1 (12.85)	70.8 (21.57)	42.8 (5.99)
Lower	BRY 6	54.7 (12.60)	71.3 (21.81)	42.4 (5.76)

[1]Period between December 21, 2001 and March 20, 2002

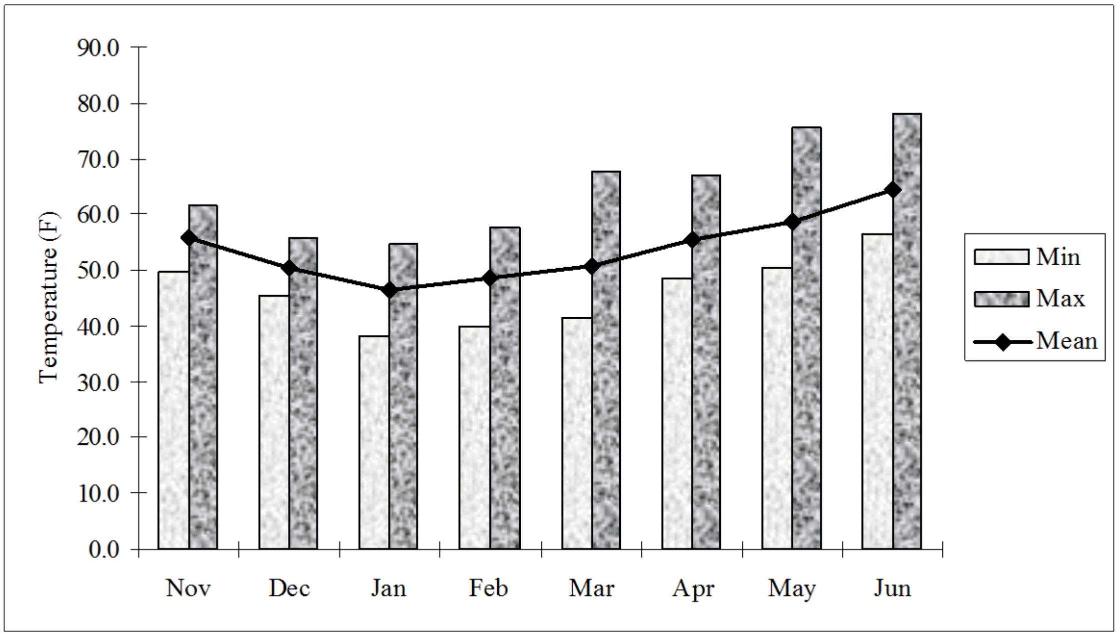

Figure 1. Station BRY 1 Temperature Fluctuation.

Monthly minimum, maximum, and average temperatures for BRY 1, representative of the upper reach of Berryessa Creek. Monitoring began November 15, 2001 and flows ended at this gauge location on June 18, 2002.

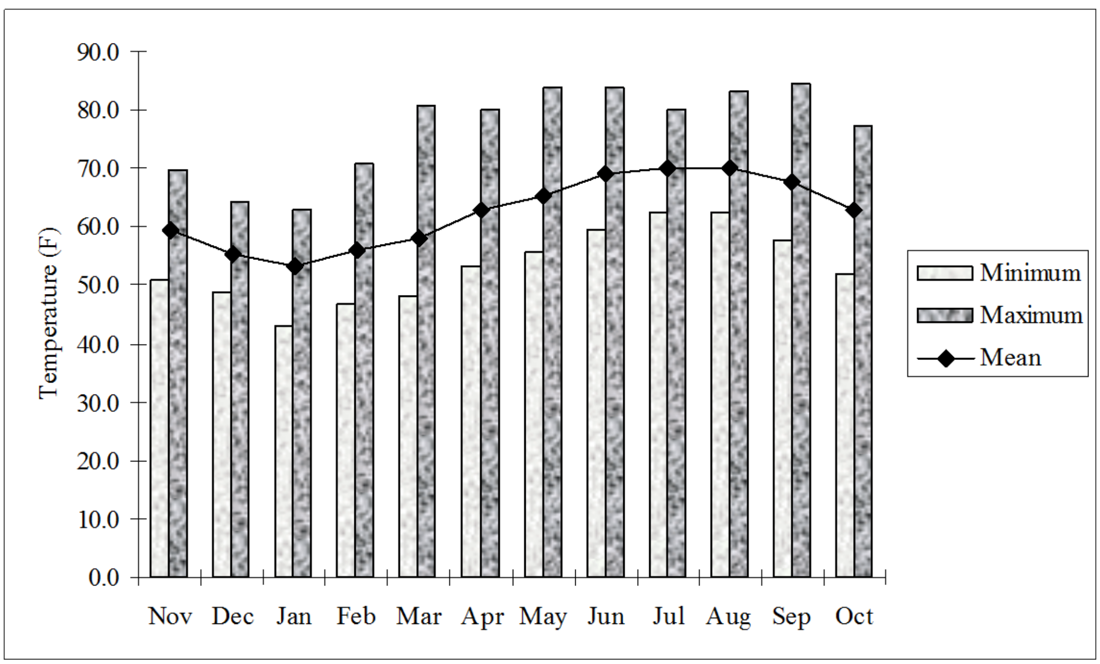

Figure 2. Station BRY 5 Temperature Fluctuation.

Monthly minimum, maximum, and average temperatures for BRY 5, representative of the lower reaches of Berryessa Creek. Monitoring began November 15, 2001 and ended November 19, 2002.

3.1. Reach 1. Upstream End of Project Area

Data from BRY 1 was available from the time of initial deployment until seasonal flow at the gauge ended in June. The last date of measurable flow occurred on June 18. As a result, data between November 15 and June 18 were analyzed. The average temperature in the upper reach was 54.5°F, with a maximum of 78.2°F and a minimum of 38.3°F. These temperatures are extremely high for the period of data collection, considering that it does not reflect summer high temperatures. Average cooler temperatures, or those below 55°F, occurred between January and April. The months of May and June both had average temperatures above 55°F. Maximum temperatures reach 55°F or above for all months. The highest maximum temperatures occur in May and June and are between 70 and 80°F.

At the BRY 2 gauge location, seasonal flow ended approximately one month earlier in the year than at BRY 1. Because data from BRY 2 represented a shorter time period, data from BRY 1 were selected to represent the upper reach. Temperatures were generally within 2 degrees of BRY1.

Figure 3 and 4 below show the temporal fluctuation in temperatures measured within the upper reach. The increased fluctuation that occurs between June and the end of the sampling period (November 2002) indicates the gauge was measuring air temperature and not water temperature. During this period there are a few periods of decreased fluctuation, which indicate that an intermittent flow occurred, likely as a result of a rainfall event.

3.2. Reach 2. Middle of Project Area

Gauges BRY 3, 4, and 5 were located within this reach, and both gauges BRY 3 and 4 were located within the greenbelt portion of the reach. BRY 5 was located at the downstream end of the project area. BRY 3 and 4 did not provide reliable water temperature data. BRY 5 provided continual water temperature recordings throughout the entire monitoring period of one year. BRY 5 provided data very similar to that of the lower reach gauge (BRY 6). Average water temperature here was 62.6°F, with a maximum of 84.7°F, and a minimum of 42.8°F.

Average monthly temperatures remain at 55°F or below for the months between December and February. The remainder of the year, average monthly temperatures are between 55 and 70°F. Maximum temperatures reach above 60°F for all months. Temperatures above 70°F are reached between February and October, and temperatures above 80°F are reached between March and September.

Data from BRY 3 and 4 only intermittently recorded water temperatures. Low flow monitoring at the greenbelt indicates that flows occurred sporadically. As a result, it is difficult to distinguish the measurements that reflect water temperature from those that reflect air temperature. Figures 5 and 6 below show the extreme fluctuations of BRY 3 and 4.

Downstream of the greenbelt area, the channel is incised and there are several drop structures present. Significant deposits of sand and gravel are located in the channel. Flows appear to occur only during rainfall events and may be subsurface during a majority of the year. A number of warm, stagnant pools have formed as a result of the existing drop structures, which trap water, and intermittent flows, which fail to flush water downstream. This area is also subject to a high level of urban runoff, which may contribute to poor water quality. Gauges were not placed within pools formed by drop structures.

During the second recording period, the casing of BRY 4 was destroyed and the gauge and all collected data for the period were lost. Again, fluctuating temperature measurements for this gauge indicates that water temperatures were not being regularly monitored. For BRY 4, which was observed to be buried beneath several inches of sediment during much of the monitoring period, data are likely a reflection of the temperature of the channel substrate.

3.3. Reach 3. Downstream of Project Area

BRY 6 recorded water temperature throughout the entire monitoring period. The average temperature was 62.6°F for the year, while the maximum temperature was 84.0°F and the minimum was 42.4°F. Although flows are year-round at this reach, average temperatures were extremely high. Average and maximum monthly temperatures are not significantly different from those of BRY 5. Figures 7 and 8 show the recorded temperatures at BRY 6. This is likely due to the close proximity of the gauges.

3.4. Effects of Temperature on the Aquatic Ecosystem

Water quality, and specifically temperature, plays a significant role in determining the species assemblage present in an aquatic ecosystem. Coyote Creek and its tributaries have been identified as having beneficial uses for warm freshwater habitat, cold freshwater habitat, wildlife habitat, preservation of listed species, fish migration, and fish spawning. Historically, these creeks supported a population of steelhead trout, along with a native assemblage of cold and warm water fish. Berryessa Creek may have once provided a migration pathway and spawning habitat for steelhead trout during seasonal flows. However, urbanization of the area has resulted in the removal of the riparian zone and floodplain wetlands, and introduced poor water quality from stormwater and industrial runoff, which has decreased the capacity of the creek to support fish and wildlife species.

Currently, within Coyote Creek, non-game fish species are supported, which are more tolerant of poor water quality conditions and low seasonal flows. Native fish present include hitch, prickly sculpin, Pacific lamprey, and possibly threespine stickleback (USACE 1988). Introduced species are now common and include carp, goldfish, and mosquito fish (*ibid*). Although studies have not evaluated fish presence in Berryessa Creek, it is likely that fish diversity is similar to that of Coyote Creek. The Central California Coast Steelhead Trout Evolutionarily Significant Unit (ESU) has been listed as threatened pursuant to the Federal Endangered Species Act (Federal Register, August 2, 1999) and the Coyote Creek watershed has been designated as Critical Habitat for this ESU (Federal Register, February 16, 2000). Only winter run steelhead are found in this ESU (NOAA 1996).

Steelhead prefer temperatures between 50-55°F (10 –13°C) (Bell 1986). Long-term exposure to sub-lethal temperatures (55-77°F, 14-25°C) weakens trout and leaves them more susceptible to disease and predation. Temperatures above 77°F (25°C) are considered to be lethal. On the average, the downstream reaches of Berryessa Creek fall within the sub-lethal temperature range. Temperatures at the upper reach fall just under the lower limit of the sub-lethal range. However, all reaches within the creek have recorded temperatures lethal for steelhead.

Adult steelhead are likely only to be present November-March, during spawning each year, while juvenile fish will migrate downstream by May or June. December and January are the only months at the lower reaches of Berryessa Creek that do not have sustained sub-lethal temperatures.

However, high temperatures are not likely to be the current limiting factor for fish migration and spawning in Berryessa Creek. A number of fish passage barriers are present, in the form of drop structures placed for erosion and flood control, as well as the presence of low or no-flow conditions. Even if man-made barriers are removed, intermittent flows in Reach 2 would prevent upstream migration of fish during most of the year. During wetter years, fish migration might be possible.

Temperatures also affect the assemblage of benthic macroinvertebrates and amphibians. Benthic organisms, which provide a prey base for fish and wildlife species, tend to thrive in cooler waters that have higher levels of dissolved oxygen. Native amphibians, such as endangered red-legged frogs, are also adapted to cooler water, while non-native species, such as bullfrogs, thrive in warmer waters.

4.0 CONCLUSIONS

Average yearly water temperatures within Berryessa Creek are high, with several months of the year sustaining average sub-lethal temperatures for steelhead. The lower reaches of the creek remain within sub-lethal temperatures for steelhead throughout the summer period. Average winter month temperatures tend to remain within suitable ranges for steelhead, with averages beneath 55°F (13°C) at all reaches, but infrequent periods of higher sub-lethal temperatures occur. Maximum temperatures during summer months often reach lethal ranges for steelhead at both the upper and lower reaches.

Water temperature, and associated dissolved oxygen levels, may be a limiting factor to production of macroinvertebrates, amphibians, or other aquatic species. However, the current limiting factor to anadromous fish spawning is the presence of several man-made fish passage barriers, as well as the seasonal nature of stream flow.

High water temperatures at Berryessa Creek primarily occur as a result of solar gain in areas where riparian vegetation is degraded or absent. A lack of riparian vegetation or other stream cover results in direct exposure to sunlight, which increases water temperatures. Slow, low flow, or pooled waters can increase in temperature rapidly and significantly when exposed to sunlight.

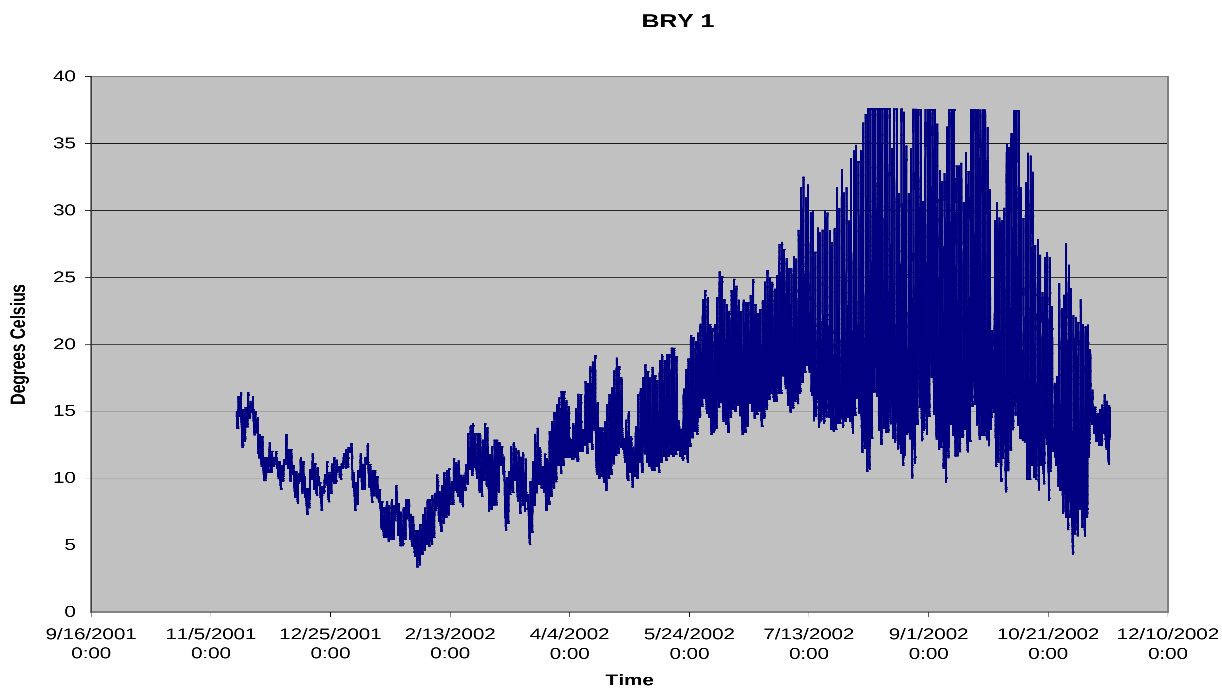

Figure 3. Water temperatures at BRY 1 in °C.

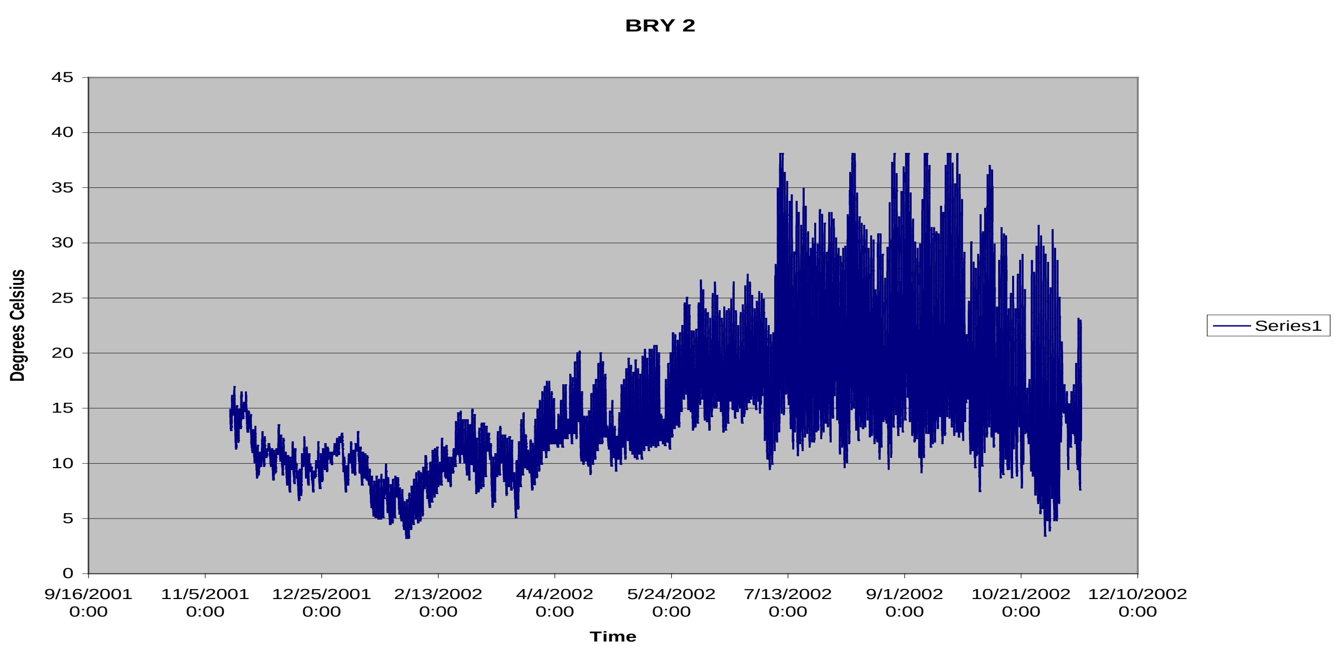

Figure 4. Water temperatures at BRY 2 in °C.

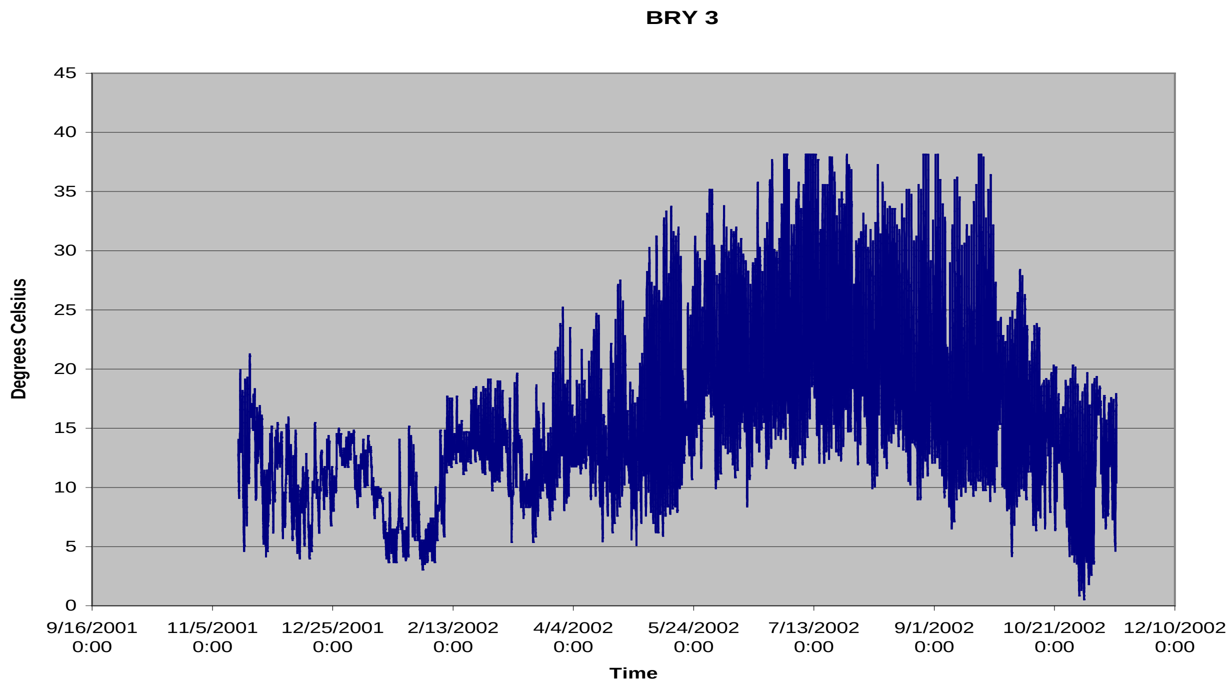

Figure 5. Water temperatures at BRY 3 in °C.

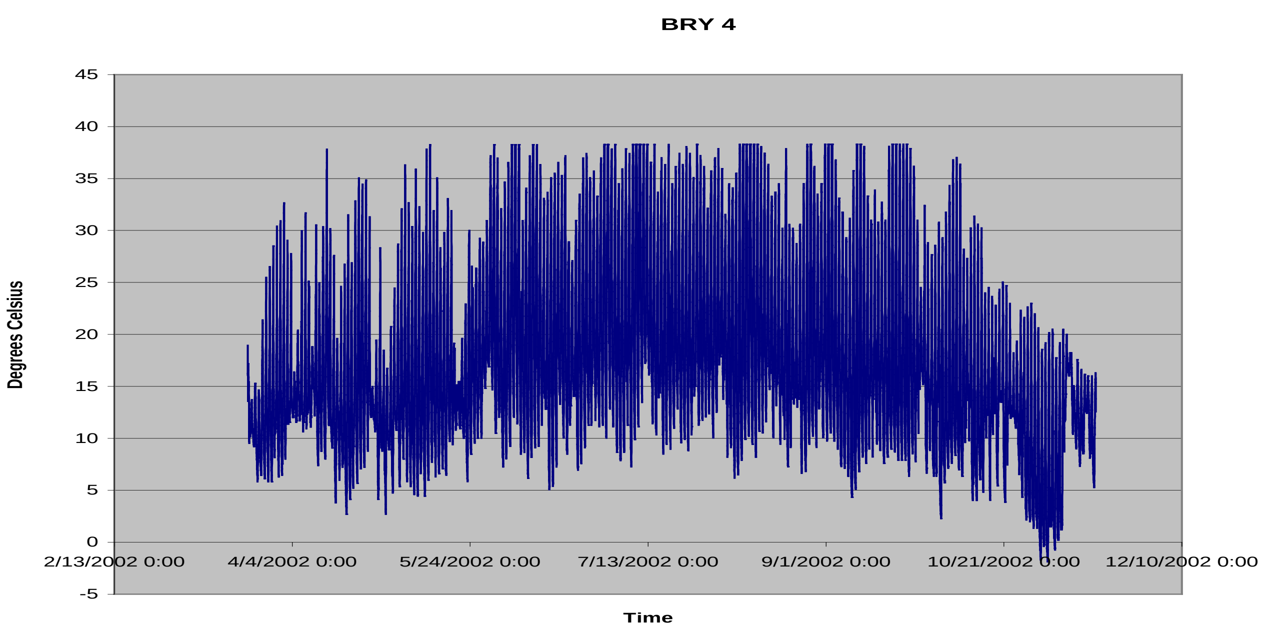

Figure 6. Water temperatures at BRY 4 in °C.

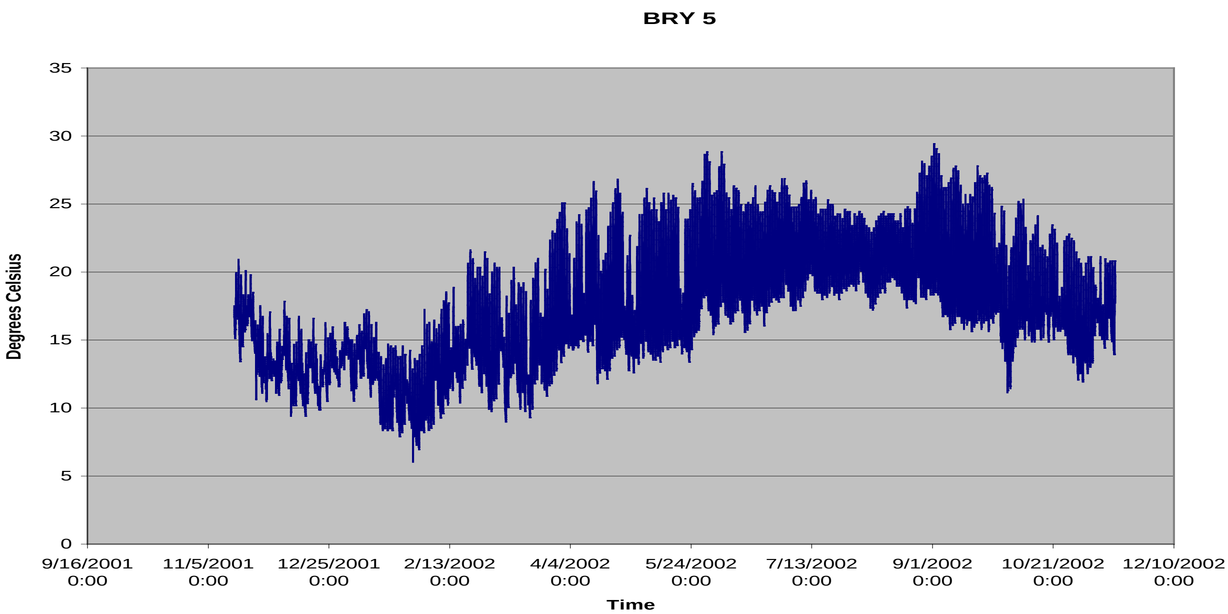

Figure 7. Water temperatures at BRY 5 in °C.

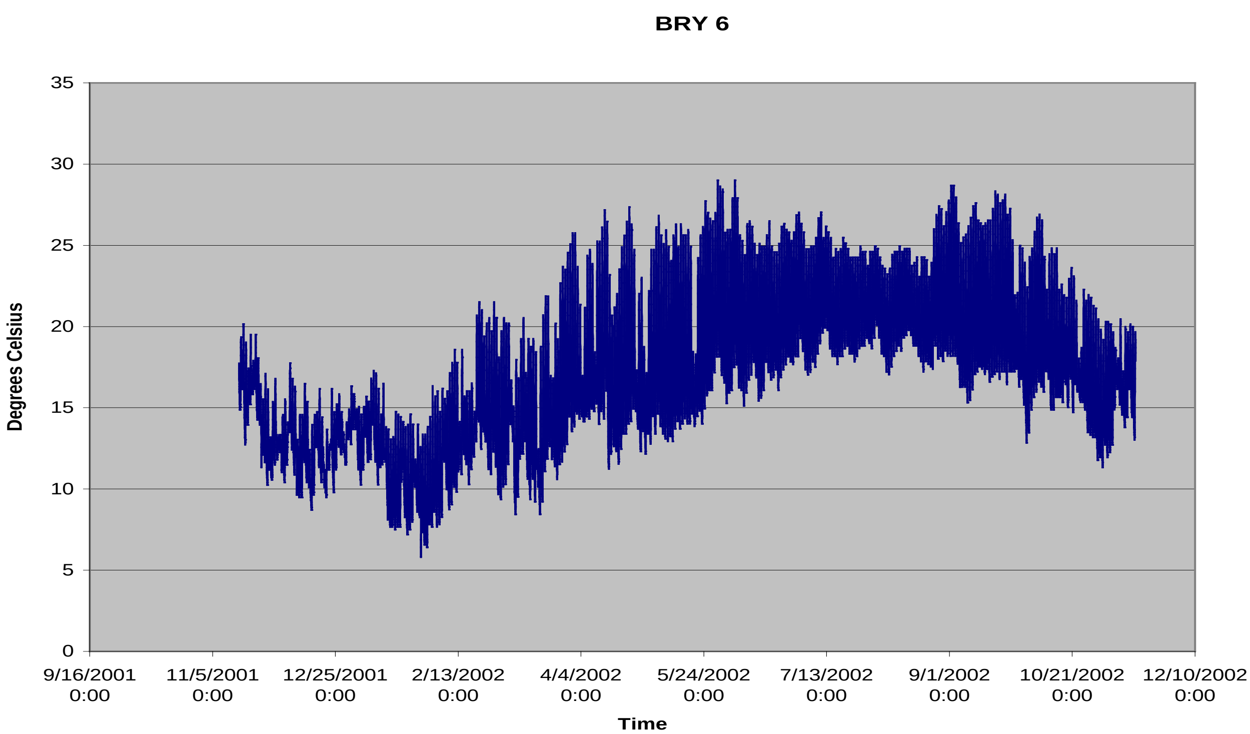

Figure 8. Water temperatures at BRY 6 in °C.

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